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Clouds and the Earth's Radiant Energy System (CERES)

Data Management System

Quality Assessment Plan

Release 1.1
DRAFT

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Preface

The Clouds and the Earth's Radiant Energy System (CERES) Data Management System supports the data processing needs of the CERES Science Team research to increase understanding of the Earth's climate and radiant environment. The CERES Data Management Team works with the CERES Science Team to develop the software necessary to support the science algorithms. This software, being developed to operate at the Langley Distributed Active Archive Center (DAAC), produces an extensive set of science data products.

The Data Management System consists of 12 subsystems; each subsystem represents a stand-alone executable program. Each subsystem executes when all of its required input data sets are available and produces one or more archival science products.

The documentation for each subsystem describes the software design at various significant milestones and includes items such as Software Requirements Documents, Data Products Catalogs, Software Design Documents, Software Test Plans, and User's Guides.

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1.0 Introduction

The Clouds and the Earth's Radiant Energy System (CERES) is a key component of the Earth Observing System (EOS). The CERES instruments are improved models of the Earth Radiation Budget Experiment (ERBE) scanner instruments, which operated from 1984 through 1990 on the National Aeronautics and Space Administration's (NASA) Earth Radiation Budget Satellite (ERBS) and on the National Oceanic and Atmospheric Administration's (NOAA) operational weather satellites NOAA-9 and NOAA-10. The strategy of flying instruments on Sun-synchronous, polar orbiting satellites, such as NOAA-9 and NOAA-10, simultaneously with instruments on satellites that have precessing orbits in lower inclinations, such as ERBS, was successfully developed in ERBE to reduce time sampling errors. CERES will continue that strategy by flying instruments on the polar orbiting EOS platforms simultaneously with an instrument on the Tropical Rainfall Measuring Mission (TRMM) spacecraft, which will have an orbital inclination of 35 degrees. In addition, to reduce the uncertainty in data interpretation and to improve the consistency between the cloud parameters and the radiation fields, CERES will include cloud imager data and other atmospheric parameters. The first CERES instrument is scheduled to be launched on the TRMM spacecraft in 1997. Additional CERES instruments will fly on the EOS-AM platforms, the first of which is scheduled for launch in 1998, and on the EOS-PM platforms, the first of which is scheduled for launch in 2000.

1.1 Purpose and Scope

The purpose of this document is to describe our plan for assuring the quality of the science data products produced by the CERES Data Management System (DMS) and to describe our Quality Assessment (QA) products and procedures. The QA products described in this document include Quality Control (QC) products, metadata, browse products, validation products, and science products which contain QA parameters. Complete product parameter listings are documented in the CERES Data Product Catalog for Release 2 (Reference 1). Complete archival product parameter definitions will be documented in a set of User's Guides scheduled to be published around the TRMM launch time frame.

A high-level view of the CERES DMS is illustrated by the CERES Top Level Data Flow Diagram shown in Figure 1-1. Circles in the diagram represent algorithm processes which are called subsystems. Subsystems are a logical collection of algorithms which together, convert input data products into output data products. Boxes represent archival data products. Two parallel lines represent data stores which are designated as nonarchival or temporary data products. Boxes or data stores with arrows entering a circle are input data sources for the subsystem, while boxes or data stores with arrows exiting the circles are output data products. This document includes descriptions of all QA products for each of the 12 subsystems. However, Figure 1-1 includes only the main input and output products. The additional products, such as QC reports and browse products are not shown in the figure. Each subsystem produces QC reports and metadata, while a selected number of the subsystems also produce browse or validation products.

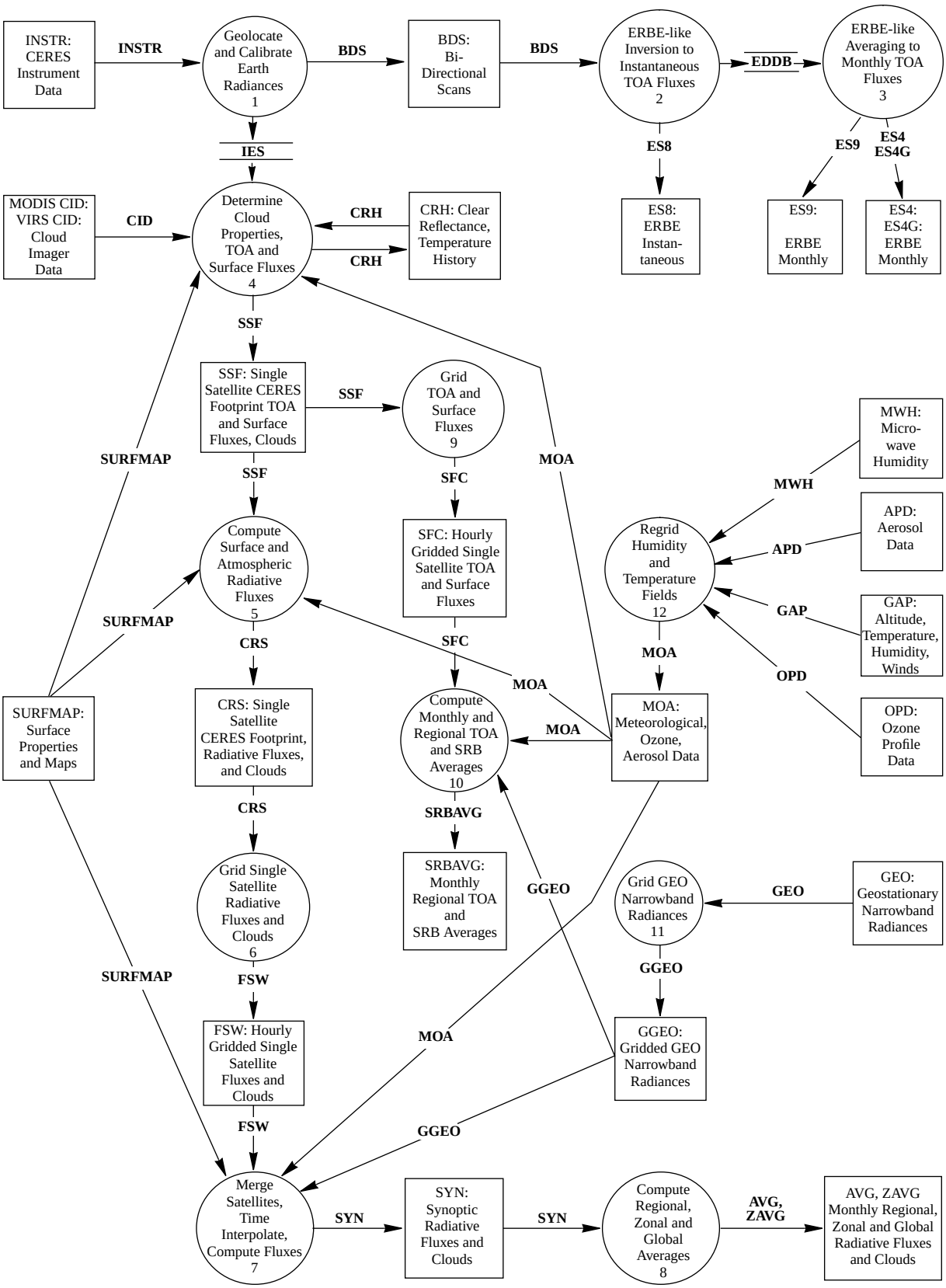

Figure 1-1. CERES Top Level Data Flow Diagram

1.2 Quality Assessment (QA) Overview

Science product quality assessment practices described in this document begin with the production of the product and extend through the time the product is released to the science community. The first type of QA occurs while the product is being produced by the science software and is referred to as automated QA. After the science product and accompanying QA products are produced, the process becomes manual in nature and may involve visual inspection and analysis. This section defines these two types of automated and manual QA. Since the science data products are produced for use by the Science Team and the Data Management Team (DMT), as well as for archival at the Langley Distributed Active Archive Center (DAAC), a brief discussion of the DAAC, the CERES Data Management Team, and the CERES Science Team roles and responsibilities is also included.

1.2.1 Automated QA

Automated QA is the QA performed by the production software, and it occurs during the generation of CERES data products at the DAAC. CERES production software includes QA calculations that are embedded into the Product Generation Executables (PGEs) or QA Executables. QA Executables (QAE) are executables that may be run outside of the main PGE, similar to a post-processing PGE that produces QA results for a day from 24 hourly files.

QA calculations may include instrument performance monitoring, parameter range checking, or comparisons with expected values. QA calculations are used to identify errors found by the algorithms, missing data, processing errors, and Good/Bad/Suspect pixels, footprints, or regions, for example. The product-specific QA parameters are currently being defined by the CERES Science Team and implemented in the production software by the Data Management Team. The product-specific QA information contained in this draft is preliminary and will be updated when further QA parameters and algorithms are defined.

Results of automated QA calculations are reported using one or more of the following mechanisms: Quality Control reports, product metadata, record level data quality flags, parameter level QA flags and fill-values in place of missing or suspect data, browse products, and validation products. Under fatal error conditions, preliminary operational plans are that the software will send an Alarm Message to an Alarm Log and to the operator monitor. Processing logs and Alarm Logs also become QA information sources. After completion of a PGE and the automated QA, the QA products will be stored on the Data Server for the manual QA process.

1.2.2 Manual QA

Manual QA is performed by human interaction and entails the visual examination of science data products and the associated QA products, such as the QC reports, product metadata, the PGE processing logs, browse products, and validation products.

1.2.2.1 DAAC Activity

The DAAC personnel will be responsible for monitoring the completion of PGEs and for reviewing Alarm Logs. DAAC personnel will look for normal processing times, normal product file sizes, and normal hardware operating conditions. The DAAC will save the PGE processing logs, along with system errors and alarms for DMT and CERES Science Team analysis whenever alarm messages have been sent to the Alarm Log. The DAAC will provide notification through e-mail of failed jobs or problems with QA they detect during processing and will report any system problems that may affect product generation to the Science Computing Facility (SCF). An additional role of the DAAC is to ensure that the data are not corrupted in the transfer, archival, or retrieval process.

1.2.2.2 SCF Activity

The majority of manual QA will be performed by the Data Management and Science Team personnel, referred to in this document as the SCF Team. DAAC operations personnel will play a support role in manual QA.

The SCF Team registers subscriptions at the DAAC in order to receive the output products to be examined. Subscriptions specify the conditions under which the SCF personnel wish to receive certain data products. The need for product QA may be based upon the automated QA results, may be based on a standard schedule, or may be standing orders. The only type of subscription available at Release A is the standing order. An example of a CERES project-wide subscription might be a standing order to receive all QC reports, or be notified that the QC reports are available for retrieval or QA purposes. A large Level 2 product might only be requested when the QC report for that product indicates a problem. Subscription conditions will vary from subsystem to subsystem and will be decided between the DAAC and the SCF for Release B. When one or more of the agreed upon subscription conditions are reached, the appropriate SCF Team members are notified that they may retrieve the data for visual analysis from the Data Server.

Algorithm and data validation are described in the CERES Validation Plan (Reference 2). QA processes are the first step in data validation and are typically limited to determining if the process ran as expected and if the data produced are as expected. QA processes occur within a near-real time window. The validation and enhancement of science algorithms are the responsibility of the Science Team and are a longer term effort, often involving comparison with other data sources.

After performing the QA analysis, the SCF personnel set a flag in the metadata indicating the status of their review. This status flag is an accessibility code, which indicates where in the QA cycle the product currently is and who has access to the product. Only when the accessibility code is set with a particular value will the data be archived and become available to the general science community. Table 1-1 lists the accessibility codes and their definition. Note that each product will be assigned an operational time-window within which the QA process is expected to be completed. The time window is the maximum time allowed for QA analysis. The time window begins once the product is available on the Data Server for manual QA analysis and ends when the product becomes available for general distribution

.

Table 1-1. Science Product Accessibility Codes

Code	Description	Discussion
1	Data available for SCF QA	Code set automatically at end of PGE after the product is completed. Automated QA completed. No QA decision made by SCF yet.
2	Data available to another internal EOS team	Data needed by data dependent instrument science teams for their processing streams - data has not been completely through the manual QA process.
3	Data available to general public	SCF completed QA and released the data for global distribution. System may default to this code when maximum time limit has expired for the particular product.
4	Data on hold; available only to SCF or DAAC	QA analysis determined problems in data; additional analysis and possible algorithm change needed. Data are not ready for archival.

1.3 QA Data Products Description

The various mechanisms for capturing QA information are listed in Table 1-2. At a minimum, all subsystems will use the first four mechanisms to assess and document information regarding the quality of their data products.

Table 1-2. CERES QA Mechanisms

Number	QA Mechanism Description
1	Information placed in the data product header / metadata
2	Record level flags embedded in the data product at the record level
3	Parameter level flags or fill-values (See Table 1-3 for a list of the fill-values) embedded in the data product for specific science parameters
4	QA information summarized in a separate QC report
5	Browse products which can be used to visually assess the quality of the corresponding data product at a high level
6	Special validation products which will assist the QA Team members in conducting a more detailed analysis of the corresponding data product

Several methods of indicating the quality of parameters are used. Certain parameters may have an accompanying flag that denotes the parameter status. Other parameters are filled with CERES default values when data are missing, when there is not enough data to make a calculation, or the

data are suspect and there is no quality flag associated with the parameter. A value which has a corresponding flag need not be set to the CERES default value when the data value is suspect. The CERES default fill values are defined as follows:

Table 1-3. CERES Fill Values

Fill Value Name	Value	Fill Value Description
INT1_DFLT	127	default value for 1-byte integer
INT2_DFLT	32767	default value for 2-byte integer
INT4_DFLT	2147483647	default value for 4-byte integer
REAL4_DFLT	3.4028235E+38	default value for 4-byte real
REAL8_DFLT	1.7976931348623157E+308	default value for 8-byte real

The following sections of the QA plan describe products involved in quality assessment for each of the CERES subsystems. This information is summarized in Table 1-4, which lists the number of the subsystem that produces the product, the CERES and EOSDIS product identification codes, a descriptive product name, and the temporal production frequency. See the Data Product Catalog for science product sizing information.

Table 1-4. CERES QA Products Summary

Sub Sys	Product Code		Name	Frequency
	CERES	EOSDIS		
1	IES	CER09	Instrument Earth Scans	1/Hour
1	IES_QC		IES Quality Control Report	1/Hour
1	BDS	CER01	BiDirectional Scan	1/Day
1	BDS_QC		BDS Quality Control Report	1/Hour
2	ES-8	CER02	ERBE-like Instantaneous TOA and Surface Estimates	1/Day
2	ES-8_QC		ES-8 Quality Control Report	1/Day
2	ES-8_Browse		ES-8 Browse product	1/Day
2	EDDB	CERX02	ERBE-like Daily Data Base	1/Month
2	EDDB_QC		EDDB Quality Control Report	1/Month
3	ES-4	CER13	ERBE-like Monthly Geographical Averages	1/Month
3	ES-4_QC		ES-4 Quality Control Report	1/Month
3	ES-4_Browse		ES-4 Browse product	1/Month

Table 1-4. CERES QA Products Summary

Sub Sys	Product Code		Name	Frequency
	CERES	EOSDIS		
3	ES-4G	CER14	ERBE-like Monthly Gridded Averages	1/Month
3	ES-4G_QC		ES-4G Quality Control Report	1/Month
3	ES-4G_Browse		ES-4G Browse product	1/Month
3	ES-9	CER03	ERBE-like Monthly Regional Averages	1/Month
3	ES-9_QC		ES-9 Quality Control Report	1/Month
3	ES-9_Browse		ES-9 Browse product	1/Month
4	SSF	CER11	Single Satellite Footprint, TOA and Surface Flux, Clouds	1/Hour
4	SSF_QC		SSF Quality Control Report	1/Hour
4	SSF_Browse		SSF Browse product	1/Hour
4	SSF_Validation		SSF Validation product	1/Hour
4	CRH	CER16	Clear Reflectance History	3/Month
4	CRH_QC		CRH Quality Control Report	3/Month
5	CRS	CER04	Single Satellite CERES Footprint, Radiative Fluxes and Clouds	1/Hour
5	CRS_QC		CRS Quality Control Report	1/Hour
6	FSW	CER05	Monthly Gridded Single Satellite Fluxes and Clouds	1/Month
6	FSW_QC		FSW Quality Control Report	1/Hour
7	SYN	CER07	Synoptic Radiative Fluxes and Clouds	Every 3 Hours
7	SYN_QC		SYN Quality Control Report	1/Month
7	SYN_Browse		SYN Browse product	1/Month
8	AVG	CER08	Monthly Regional Radiative Fluxes and Clouds	1/Month
8	AVG_QC		AVG Quality Control Report	1/Month
8	AVG_Browse		AVG Browse Product	1/Month
8	ZAVG	CER15	Monthly Zonal and Global Radiative Fluxes and Clouds	1/Month
8	ZAVG_QC		ZAVG Quality Control Report	1/Month
8	ZAVG_Browse		ZAVG Browse Product	1/Month
9	SFC	CER12	Monthly Gridded Single Satellite TOA and Surface Fluxes/Clouds	1/Month

Table 1-4. CERES QA Products Summary

Sub Sys	Product Code		Name	Frequency
	CERES	EOSDIS		
9	SFC_QC		SFC Quality Control Report	1/Month
10	SRBAVG	CER06	Monthly TOA and SRB Averages	1/Month
10	SRBAVG_QC		SRBAVG Quality Control Report	1/Month
10	SRBAVG_Browse		SRBAVG Browse Product	1/Month
11	GGEO	CERX14	Gridded GEO Narrowband Radiances	1/Month
11	GGEO_QC		GGEO Quality Control Report	1/Month
12	MOA	CERX06	Meteorological, Ozone, & Aerosols	1/Hour
12	MOA_QC		MOA Quality Control Report	1/Month

2.0 QA Products

This section is a preliminary description of the CERES QA mechanisms that accompany each science data product. The mechanisms are listed in Table 1-2. Each subsection contains a summary overview of the science data product followed by the QA mechanisms implemented for that product. These listings are preliminary and are still under development. Our QC, metadata, browse, validation, and header record requirements are not finalized and are not discussed extensively in this draft. They are included as place holders for future revisions.

2.1 Instrument Earth Scan (IES) Quality Flags (CER09)

The IES data product contains the equivalent of one hour of data from a single CERES scanner. The data records are time-ordered, but read routines are available to serve data along the orbital ground track, with each footprint position related to the spacecraft's suborbital point at the start of the hour. The spatial ordering of records will ease the convolution of CERES data with cloud imager data in Subsystem 4. The footprint record is the basic data structure for this data product. This record contains the following kinds of information:

1) Time of observation
2) Geolocation data (at both the Top-of-Atmosphere (TOA) and at Earth's surface)
3) Filtered radiances (at satellite altitude), with associated quality measures
4) Spacecraft orbital data
5) Footprint viewing geometric data

The IES data product contains only measurements that view the CERES Top-of-the-atmosphere (TOA). For the TRMM mission, this means that approximately 225 Earth-viewing footprints (records) are stored on the IES from each 3.3 second normal half-scan. Because the Earth scan pattern of the CERES instrument in the biaxial scan mode is irregular, the exact number of footprints or records in each IES data product varies.

2.1.1 IES Header Record / Metadata QA

Table 2-1. IES Header Quality Indicators

Indicator Description	Data Type	Definition
Number of Footprints	32-bit Integer	1 to 299,000

2.1.2 IES Footprint Record QA

2.1.3 IES Parameter QA

Table 2-2. IES Footprint Quality Flags (32 bits)

Flag Description	Number of Bits	Bit Definition
Spare	1 bit	
Field-of-View Flag	2 bits	00 = Hit Earth 01 = Hit TOA, Missed Earth 11 = Missed TOA and Earth Note: By definition this flag will be 00 for all footprints in the IES.
Shortwave Radiance Flag	2 bits	00 = Good 01 = Calculated (Questionable) 11 = Bad
Window Radiance Flag	2 bits	00 = Good 01 = Calculated (Questionable) 11 = Bad
Total Radiance Flag	2 bits	00 = Good 01 = Calculated (Questionable) 11 = Bad
Instrument Mode	2 bits	00 = Fixed Azimuth Plane Scan 01 = Rotating Azimuth Plane Scan 11 = Transitional/Other
Elevation Scan Mode	4 bits	0000 = Normal Earth Scan Profile 0001 = Short Earth Scan Profile 0010 = MAM Scan Profile 0011 = Nadir Scan Profile 0100 = Stowed All others = Other Profiles
Azimuth Assembly Status	1 bit	0 = Fixed 1 = In Motion
Spare	16 bits	

2.1.4 IES Quality Control QA

2.2 Bidirectional Scans (BDS) Quality Flags (CER01)

The BDS data product is an archival product containing level 1b CERES scanner data obtained for a 24-hour period. All science scan modes are included in the BDS, including the fixed and rotating azimuth scan modes that perform normal Earth, internal calibration, and short scan elevation profiles. The BDS product includes samples taken at all scan elevation positions (including space looks and internal calibration views).

The BDS includes the raw count data stream and the converted engineering representative data. These data are divided into the following seven groups that are carried forward from the Level-0 product:

1) Time
2) Instrument Status
3) Radiometric Channel Counts
4) Instrument Telescope Pointing (elevation and azimuth)
5) Temperatures
6) Voltages and Currents
7) Satellite Ephemeris and Ancillary Data

In addition, we add the following filtered radiance data from the three radiometric channels and their associated field-of-view location geometry:

1) Filtered Radiances, including quality flags
2) Earth Location Geometry, including quality flags

In the BDS data product, the filtered radiances and the Earth location geometry are considered a multiband, single data element footprint. Quality flags are used to indicate the reliability of the radiance and Earth location measurements. This product is also used to diagnose instrument performance conditions.

2.2.1 BDS Header Record / Metadata QA

Table 2-3. BDS Header Quality Indicators

Indicator Description	Data Type	Definition
Number of Scans	32-bit Integer	1 to 13091

2.2.2 BDS Data Record QA

2.2.3 BDS Parameter QA

Except for the Field-of-View Flag shown below, the BDS parameter level quality flags are the same as the IES quality flags (see Table 2-2.)

Table 2-4. BDS Quality Flags (32 bits)

Flag Description	Number of Bits	Bit Definition
Field-of-View Flag	2 bits	00 = Hit Earth 01 = Hit TOA, Missed Earth 11 = Missed TOA and Earth

2.2.4 BDS Quality Control QA

2.3 ERBE-like Instantaneous TOA Estimates (ES-8) Quality Flags (CER02)

The ES-8 data product contains a 24-hour, single-satellite, instantaneous view of scanner fluxes at the top-of-atmosphere reduced from spacecraft altitude unfiltered radiances using the ERBE scanner Inversion algorithms and the ERBE shortwave (SW) and longwave (LW) Angular Distribution Models (ADMs). The ES-8 also includes the SW, LW, and window (WN) channel radiometric data; SW, LW, and WN unfiltered radiance values; and the ERBE scene identification results on a footprint basis. This data is organized according to the CERES 3.3-second scan into 6.6-second records. As long as there is one valid scanner measurement within a record, the ES-8 record will be generated.

2.3.1 ES-8 Header Record / Metadata QA

2.3.2 ES-8 Data Record QA

2.3.3 ES-8 Parameter QA

ES-8 contains the following footprint-level flag words:

1) Scanner operations flag words (2 32-bit words)
2) Quality flag for total radiance value (33 32-bit words)
3) Quality flag for shortwave radiance value (33 32-bit words)
4) Quality flag for window radiance value (33 32-bit words)
5) Quality flag for FOV (33 32-bit words)

Table 2-5. ES-8 Scanner Operation Quality Flags, Word 1 (32 bits) (1 of 2)

Flag Description	Number of Bits	Bit Definition
Instrument Power	1 bit	0 = power ON 1 = power OFF
Viewing Vectors	2 bits	00 = calculating MAM and earth-viewing vectors 01 = calculating MAM viewing vectors only 10,11 = not calculating viewing vectors
Telemetry	1 bit	0= No telemetry data dropout 1 = Telemetry data dropout
Elevation Motor Power	2 bits	00 = elevation motor power ON 01 = elevation motor power OFF 10, 11 = elevation motor power undefined
Azimuth Motor Power	2 bits	00 = azimuth motor power ON 01 = azimuth motor power OFF 10, 11 = azimuth motor power undefined
Post Calibration Operation	2 bits	00 = this is the first record since the end of a solar calibration 01 = this is the first record since the end of an internal calibration. 10,11 = no calibration sequence ended in the previous record

Table 2-5. ES-8 Scanner Operation Quality Flags, Word 1 (32 bits) (2 of 2)

Flag Description	Number of Bits	Bit Definition
Solar Calibration	2 bits	00 = solar calibration in progress 01 = solar calibration not in progress 10,11 = status of solar calibration is undefined
Internal Calibration	2 bits	00 = internal calibration in progress 01 = internal calibration not in progress 10,11 = status of internal calibration is undefined
Scanner Value	1 bit	0 = at least one scanner radiometric value has both a good radiometric flag and a good FOV flag 1 = above situation does not exist
Spare	17 bits	

Table 2-6. ES-8 Scanner Operation Quality Flags, Word 2 (32 bits) (1 of 2)

Flag Description	Number of Bits	Bit Definition
Scanner Mode	3 bits	000 = normal Earth scan 001 = nadir Earth scan 010 = short Earth scan 011 = MAM scan 100 = stowed position 101,110,111 = mode is undefined
Last Azimuth Command	3 bits	If the azimuth motor power is OFF, then the azimuth position is given below. If the azimuth motor power is ON, then the scanner is in transit to that azimuth position. A and B are stored azimuth values. 000 = go to azimuth position A 001 = go to azimuth position B 010 = go to azimuth of 0 degrees 011 = go to azimuth of 90 degrees 100 = go to azimuth of 180 degrees 101 = azimuth is continuously changing between 0 and A degrees 110,111 = the last azimuth command is undefined

Table 2-6. ES-8 Scanner Operation Quality Flags, Word 2 (32 bits) (2 of 2)

Flag Description	Number of Bits	Bit Definition
Last SWICS command	3 bits	000 = turn power off 001 = go to power level 3 010 = go to power level 3 and modulate 011 = go to power level 2 100 = go to power level 2 and modulate 101 = go to power level 1 110 = go to power level 1 and modulate 111 = the last SWICS command is undefined
Solar Calibration Azimuth Position	3 bits	000 = azimuth at B 001 = azimuth at A prior to sun encounter 010 = azimuth at neither A or B 011 = azimuth at A after sun encounter 100,101,110,111 = azimuth position is undefined
Housekeeping Data	1 bit	0 = no new housekeeping data is available for this data, or the new data is questionable 1 = new housekeeping data is available for this record
Spare	19 bits	

Table 2-7. Total Radiance Value Quality Flags (32 bits)

Flag Description	Number of Bits	Bit Definition
Total Channel Data Quality	14 bits	For each bit, 0 = corresponding radiance value is good 1 = corresponding radiance value is bad
Spare	18 bits	

Table 2-8. Shortwave Radiance Value Quality Flags (32 bits)

Flag Description	Number of Bits	Bit Definition
Shortwave Channel Data Quality	14 bits	For each bit, 0 = corresponding radiance value is good 1 = corresponding radiance value is bad
Spare	18 bits	

Table 2-9. Window Radiance Value Quality Flags (32 bits)

Flag Description	Number of Bits	Bit Definition
Window Channel Data Quality	14 bits	For each bit, 0 = corresponding radiance value is good 1 = corresponding radiance value is bad
Spare	18 bits	

Table 2-10. FOV Quality Flags (32 bits)

Flag Description	Number of Bits	Bit Definition
FOV Data Quality	14 bits	For each bit, 0 = FOV is good 1 = FOV is bad
Spare	18 bits	

2.3.4 ES-8 Quality Control QA

Figure 2-1 (the QC report) shown below contains QC information for Subsystem 2.0.

INVERSION MAIN PROGRAM PROCESSING SUMMARY

PAGE: 1

CERES PRODUCT: EQC - 7
DATE PROCESSED: 1996/10/28 13:17:00
SATELLITE: ERBS
TEMPORAL SPAN: 1985/08/13 0000 - 1985/08/13 2359
INSTRUMENT: SCANNER
SYSTEM RELEASE: 1
CHANNEL: ALL
SOFTWARE VERSION: 1
UNITS: VARIOUS
DATA ALTITUDE: TOA

****
ORBIT AND DATA
****

		BLACKOUT										OPENED	CLOSED NORMAL	CLOSED FINAL	MAX REMAIN	
NUMBER OF RECORDS	5371	START(	TIME	COLAT	LONG)	STOP(	TIME	COLAT	LONG)	LENGTH	ACTIVE 2.5 REG	4050	4035	15	20	0
PERCENT FULL RECORDS	99	7	49 51.95	127.9	56.5	7	50 23.95	129.3	58.2	0.53						
COMPUTER TIME (MIN)	1	7	39 11.95	96.3	32.9	7	39 27.96	97.1	33.4	0.27						
WALL TIME (MIN)	2	3	44 15.95	63.0	287.7	3	44 31.95	62.2	288.3	0.27						
		8	17 19.95	115.6	181.0	8	17 35.95	114.8	181.6	0.27						
		8	28 31.95	81.1	202.2	8	28 47.95	80.2	202.7	0.27						

OUTPUT TO DAILY	YES	NO. OF DATA BLACKOUTS	28		
		NO. OF SCAN SCENE IDENTIFIED UNKNOWN	4114	EARTH SPIN (DEG/SEC)	0.004178
		NO. OF SCAN EST REJECTED ON MIN ALBEDO (0.02)	0	SOLAR CONSTANT (W/M**2)	1365.000000
		NO. OF SCAN EST REJECTED ON MAX ALBEDO (1.00)	45	ALTITUDE TOA (KM)	30.000000
		NO. OF LW SCAN EST REJECTED ON MIN RAD EX(50.00)	0	RADIUS OF EARTH (KM)	6371.017000
OUTPUT TO ES8	YES	NO. OF LW SCAN EST REJECTED ON MAX RAD EX(400.00)	0	PI	3.141593
		NO. OF SCAN MEAS REJECTED ON MAX VIEW ZEN(70.00)	86284	DEG TO RAD CONVERSION	0.017453
		NO. OF SCAN MEAS REJECTED ON MAX BIDIRECT(2.00)	4114	RAD TO DEG CONVERSION	57.295780
		NO. OF SCAN MEAS REJECTED ON ID SIGMA (8.00)	0	SEMI-MAJOR AXIS	6974.095269
		NO. OF SCAN MEAS REJECTED ON CONSISTENCY (10.00)	0	ECCENTRICITY	0.002777
		BAD SCANNER RECORD LEVEL FLAGS	20	ARGUMENT OF PERIGEE	93.387472
				TRUE ANOMALY	-174.210306
				INCLINATION	56.984338
				LONG OF ASCENDING NODE	-34.874759
				ORBITAL PERIOD	96.603183

Figure 2-1. Inversion Main Program Processing Summary (1 of 5)

INVERSION MAIN PROGRAM PROCESSING SUMMARY

PAGE: 2

CERES PRODUCT: EQC - 7
DATE PROCESSED: 1996/10/28 13:17:00
SATELLITE: ERBS
TEMPORAL SPAN: 1985/08/13 0000 - 1985/08/13 2359
INSTRUMENT: SCANNER
SYSTEM RELEASE: 1
CHANNEL: ALL
SOFTWARE VERSION: 1
UNITS: COUNTS, PERCENT
DATA ALTITUDE: TOA

****
SAMPLING AND SCENE
****

COLAT	NUMBER SAMPLED GOOD MEAS SW(DA)	WN	TOT	DA/NT	GEOGRAPHIC SAMPLED/MODELED OCEAN	LAND	SNOW	DESERT	MIX	CLOUDS CLR	PC	MC	OV	AMT	CLR O	L	S	D	PC M	O	L	MC M	O	L	M	OV
N	0	0	0	0/ 0	0/ 9	0/ 0	0/ 91	0/ 0	0/ 0*	0	0	0	0	0 *	0	0	0	0	0 *	0	0	0 *	0	0	0 *	0 *
2	0	0	0	0/ 0	0/51	0/10	0/ 28	0/ 0	0/11*	0	0	0	0	0 *	0	0	0	0	0 *	0	0	0 *	0	0	0 *	0 *
3	0	0	0	0/ 0	0/22	0/62	0/ 4	0/ 0	0/12*	0	0	0	0	0 *	0	0	0	0	0 *	0	0	0 *	0	0	0 *	0 *
4	52352	0	164147	31/ 68	37/39	55/53	0/ 0	0/ 0	8/ 8*	5	22	54	19	64 *	1	3	0	0	1 *	2	18	1 *	27	24	4 *	19 *
5	55401	0	110337	50/ 49	43/45	36/33	0/ 0	13/14	8/ 8*	12	38	38	12	50 *	2	3	0	5	1 *	9	28	3 *	25	11	2 *	11 *
6	47016	0	92550	50/ 49	55/54	25/27	0/ 0	13/12	7/ 7*	30	39	23	8	36 *	13	4	0	9	4 *	22	14	3 *	14	8	1 *	8 *
7	43590	0	85508	50/ 49	62/60	12/14	0/ 0	20/21	6/ 5*	28	40	20	12	38 *	8	1	0	17	3 *	34	3	2 *	13	6	1 *	12 *
8	41732	0	83571	49/ 50	76/70	10/13	0/ 0	9/10	5/ 7*	11	31	25	33	59 *	4	0	0	5	1 *	25	4	2 *	19	5	1 *	34 *
9	41250	0	82576	49/ 50	77/76	18/18	0/ 0	1/ 2	4/ 4*	6	27	36	31	64 *	6	0	0	0	0 *	24	2	1 *	31	5	1 *	30 *
10	41504	0	82590	50/ 49	76/74	20/20	0/ 0	0/ 1	4/ 5*	20	44	25	11	41 *	13	7	0	0	0 *	35	8	2 *	21	2	1 *	11 *
11	42314	0	84454	50/ 49	76/76	16/17	0/ 0	3/ 3	5/ 4*	36	46	16	2	27 *	18	13	0	2	2 *	40	4	3 *	16	0	0 *	2 *
12	43714	0	87327	50/ 49	77/76	11/11	0/ 0	8/10	4/ 3*	33	48	15	4	29 *	14	9	0	8	2 *	45	2	2 *	14	0	0 *	4 *
13	46532	0	92739	50/ 49	84/88	8/ 7	0/ 0	4/ 2	4/ 3*	10	51	28	11	45 *	7	2	0	1	0 *	43	6	2 *	25	2	1 *	11 *
14	53532	0	108136	49/ 50	97/96	1/ 1	0/ 0	0/ 1	2/ 2*	2	25	43	30	67 *	2	0	0	0	0 *	24	0	0 *	44	0	0 *	30 *
15	106501	0	159151	66/ 33	99/98	1/ 1	0/ 0	0/ 0	0/ 1*	2	10	53	35	75 *	2	0	0	0	0 *	10	0	0 *	53	0	0 *	35 *
16	0	0	0	0/ 0	0/87	0/ 0	0/ 7	0/ 0	0/ 6*	0	0	0	0	0 *	0	0	0	0	0 *	0	0	0 *	0	0	0 *	0 *
17	0	0	0	0/ 0	0/27	0/ 0	0/ 67	0/ 0	0/ 6*	0	0	0	0	0 *	0	0	0	0	0 *	0	0	0 *	0	0	0 *	0 *
S	0	0	0	0/ 0	0/ 4	0/ 0	0/ 95	0/ 0	0/ 1*	0	0	0	0	0 *	0	0	0	0	0 *	0	0	0 *	0	0	0 *	0 *
GLOB	615438	0	1233086	50/ 50						14	33	35	18	52 *	6	3	0	3	1 *	23	7	1 *	31	6	1 *	18 *
BAD	45292	1327048	93962																							
TOT	660730	1327048	1327048																							

Figure 2-1. Inversion Main Program Processing Summary (2 of 5)

INVERSION MAIN PROGRAM PROCESSING SUMMARY

PAGE: 3

SATELLITE: ERBS
INSTRUMENT: SCANNER
CHANNEL: ALL
UNITS: COUNTS, PERCENT

CERES PRODUCT: EQC - 7
DATE PROCESSED: 1996/10/28 13:17:00
TEMPORAL SPAN: 1985/08/13 0000 - 1985/08/13 2359
SYSTEM RELEASE: 1
SOFTWARE VERSION: 1
DATA ALTITUDE: TOA

	********* DAY *********						******** NIGHT *********						*		********* DAY *********						*	SELECTED SCENE SIGMA DEPARTURE					
V.ZEN	NUM	CLR	PC	MC	OV	AMT	NUM	CLR	PC	MC	OV	AMT	*	S.ZEN	NUM	CLR	PC	MC	OV	AMT	*	SIGMA	NUM	SIGMA	NUM	SIGMA	NUM
0-10	14	18	33	32	17	49	14	11	34	37	19	55	*	0-10	0	0	0	0	0	0	*	1	810112	11	0	21	0
10-20	14	18	33	32	17	49	14	11	34	36	19	54	*	10-20	0	0	0	0	0	0	*	2	362736	12	0	22	0
20-30	14	20	32	31	17	48	14	12	34	35	19	54	*	20-30	0	0	0	0	0	0	*	3	50274	13	0	23	0
30-40	14	20	31	32	18	50	14	12	35	35	19	54	*	30-40	5	17	41	29	13	45	*	4	5480	14	0	24	0
40-50	13	19	31	33	18	50	13	12	35	35	19	54	*	40-50	32	27	36	25	11	39	*	5	529	15	0	25	0
50-60	13	17	31	33	20	52	13	12	35	35	19	54	*	50-60	18	22	38	25	16	45	*	6	51	16	0	26	0
60-70	11	16	31	35	19	53	11	11	35	35	19	54	*	60-70	16	12	33	37	18	54	*	7	1	17	0	27	0
70-80	7	10	32	41	17	55	7	8	27	43	22	60	*	70-80	14	8	24	44	24	62	*	8	0	18	0	28	0
80-90	0	0	0	0	0	0	0	0	0	100	0	73	*	80-90	14	8	17	45	30	67	*	9	0	19	0	29	0
													*								*	10	0	20	0	30 +	0
TOTAL	100	18	32	33	18	51	100	11	34	36	19	54	*	TOTAL	100	18	32	33	18	51	*						

		(MEAS TOO HOT)							LW SIGMA OF SELECTED SCENE							(MEAS TOO COLD)
		.GT.6	5TO6	4TO5	3TO4	2TO3	1TO2	0TO1	ALL LW	0TO-1	-1TO-2	-2TO-3	-3TO-4	-4TO-5	-5TO-6	.LT.-6
	.GT.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	5TO6	0	0	0	0	0	0	0	38	10	28	0	0	0	0	0
R	4TO5	0	0	0	0	0	0	1	109	41	67	0	0	0	0	0
I S	3TO4	0	0	0	0	0	0	18	390	177	181	14	0	0	0	0
G W	2TO3	0	0	0	0	0	20	1986	5726	1867	1127	305	420	1	0	0
H	1TO2	0	0	0	1	21	1001	22509	62300	25780	9908	2717	361	2	0	0
T S	0TO1	0	0	7	48	398	7064	60175	190657	79582	38649	4594	140	0	0	0
I																
G	ALL SW	0	0	7	82	1405	25585	410849	0	555460	208548	24210	2936	101	0	0
M																
A	0TO-1	0	0	0	33	258	6781	84631	275438	114049	62211	7341	134	0	0	0
	-1TO-2	0	0	0	0	51	1136	14630	70090	39408	13835	972	58	0	0	0
D	-2TO-3	0	0	0	0	0	86	1106	6212	3567	1273	172	8	0	0	0
A	-3TO-4	0	0	0	0	0	16	15	321	151	118	21	0	0	0	0
R	-4TO-5	0	0	0	0	0	1	0	38	13	18	6	0	0	0	0
K	-5TO-6	0	0	0	0	0	0	0	5	0	5	0	0	0	0	0
	.LT.-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	NIGHT	0	0	0	0	677	9480	225778	617859	290815	81128	8068	1815	98	0	0

Figure 2-1. Inversion Main Program Processing Summary (3 of 5)

INVERSION MAIN PROGRAM PROCESSING SUMMARY

PAGE: 4

CERES PRODUCT: EQC - 7
DATE PROCESSED: 1996/10/28 13:17:00
TEMPORAL SPAN: 1985/08/13 0000 - 1985/08/13 2359
SYSTEM RELEASE: 1
SOFTWARE VERSION: 1
DATA ALTITUDE: TOA

SATELLITE: ERBS
INSTRUMENT: SCANNER
CHANNEL: ALL
UNITS: W/M**2, COUNTS, PERCENT, CM

****
2.5-DEG
STATISTIC DATA
****

****** TOA FLUX ******

COLAT	SW/N		LW/N		ALB
N	0/	0	0/	0	0
2	0/	0	0/	0	0
3	0/	0	0/	0	0
4	60/	137	227/	573	38
5	158/	181	248/	377	40
6	170/	139	265/	295	27
7	214/	128	261/	259	27
8	243/	122	233/	252	27
9	260/	122	234/	250	26
10	199/	121	267/	250	20
11	188/	124	283/	251	19
12	191/	140	273/	279	20
13	205/	163	244/	321	24
14	236/	197	216/	394	35
15	176/	318	198/	549	46
16	0/	0	0/	0	0
17	0/	0	0/	0	0
S	0/	0	0/	0	0
GLOB	199/	1892	250/	4050	27

Figure 2-1. Inversion Main Program Processing Summary (4 of 5)

INVERSION MAIN PROGRAM PROCESSING SUMMARY

PAGE: 5

CERES PRODUCT: EQC - 7
DATE PROCESSED: 1996/10/28 13:17:00
TEMPORAL SPAN: 1985/08/13 0000 - 1985/08/13 2359
SYSTEM RELEASE: 1
SOFTWARE VERSION: 1
DATA ALTITUDE: TOA

SATELLITE: ERBS
INSTRUMENT: SCANNER
CHANNEL: ALL
UNITS: W/M**2

****
SW OFFSETS
****

	YYYY/MM/DD - HH/MM/SS
INITIAL TIME FROM PRIMARY INPUT HEADER	1985 8 13 0 0 15.95

ORBIT NO.	OFFSETS	*	TIME DIFF (MIN)
1	0.273	*	38.133
2	0.377	*	96.800
3	0.128	*	96.800
4	0.285	*	96.533
5	0.294	*	96.800
6	0.196	*	96.800
7	0.214	*	96.800
8	0.469	*	96.800
9	0.392	*	96.533
10	0.161	*	96.800
11	0.076	*	96.800
12	0.139	*	96.800
13	0.336	*	96.533
14	0.327	*	96.800
15	0.319	*	96.800

REJECTS DUE TO INSUFFICIENT DATA (200)	0
REJECTS DUE TO EXCEEDING LIMIT (5)	0
NIGHTTIME TO NIGHTTIME DATA DROP OUT PERIODS	0
DAYTIME TO DAYTIME DATA DROP OUT PERIODS	0
NIGHTTIME TO DAYTIME DATA DROP OUT PERIODS	0

Figure 2-1. Inversion Main Program Processing Summary (5 of 5)

2.3.5 ES-8 Browse Product QA

2.4 ERBE-like Daily Data Base (EDDB) Quality Flags (CERX02)

2.4.1 EDDB Header Record / Metadata QA

2.4.2 EDDB Record QA

2.4.3 EDDB Parameter QA

The mechanism used to designate suspect data in this data product is to insert CERES fill values in the place of the parameter value when there is no data, when there is not enough data to make a calculation, or when the data calculated is out of range.

2.4.4 EDDB Quality Control QA

Figure 2-1 contains QC information from Subsystem 2.0, ERBE-like Inversion, which includes information about the processing in general as well as information related to the ES-8 and EDDB products.

2.5 ERBE-like Monthly Geographical Averages (ES-4) Quality Flags (CER13)

The ES-4 data is a regional, zonal, and global averages product. The instantaneous scanner estimates at the TOA are arranged temporally to hours, days, and the month. They are averaged spatially to regions, latitude zones, and the globe. The ES-4 product contains a header record, a record of file address map, a record of data scale factors, and seven sets of data records. Each record data set corresponds to a regional, nested regional, zonal, or global average. There are 10368 2.5-degree regions for the ERBE-like data. Therefore, there is a maximum of 10368 records in the 2.5-degree regional record set. The second set of data records is the 2.5-degree nested to 5.0-degree regional data, which constitutes 2592 records. The third set of data records is the 5.0-degree nested to 10.0-degree regional data, which constitutes 648 records. The fourth, fifth, and sixth sets of records are the 2.5-degree, 5.0-degree, and 10.0-degree zonally averaged data which constitute 72, 36, and 18 records, respectively. The last set is the global data, which constitutes 3 records.

2.5.1 ES-4 Header Record / Metadata QA

2.5.2 ES-4 Record QA

2.5.3 ES-4 Parameter QA

The mechanism used to designate suspect data in this data product is to insert CERES fill values in the place of the parameter value when there is no data, when there is not enough data to make a calculation, or when the data calculated is out of range.

2.5.4 ES-4 Quality Control QA

2.5.5 ES-4 Browse Product QA

2.6 ERBE-like Monthly Gridded Averages (ES-4G) Quality Flags (CER14)

The ES-4G data product stores the same time and space averages as the ES-4 science data product, with the difference being the arrangement of the data. While the ES-4 is arranged by region, the ES-4G files present a gridded data product with all regions for a given data parameter grouped together. The regional presentation of the data is in the same order as that described for the ES-4 product. The 2.5-degree regional parameters are presented as 10368-element vectors, the 2.5 nested to 5.0-degree data is presented as 2592-element vectors, and the 5.0 nested to 10.0-degree data is presented as 648-element vectors. The 2.5-, 5.0-, and 10.0-degree zonal data is presented as 72-, 36-, and 18-element vectors respectively. The global data are presented as 3-element vectors.

The ES-4G data product is written on four output files. The first three files contains 2.5-deg regional data, 32-bit, 16-bit, and 8-bit data. The fourth file contains nested regional data, all zonal data, and global data.

2.6.1 ES-4G Header Record / Metadata QA

2.6.2 ES-4G Record QA

2.6.3 ES-4G Parameter QA

The mechanism used to designate suspect data in this data product is to insert CERES fill values in the place of the parameter value when there is no data, when there is not enough data to make a calculation, or when the data calculated is out of range.

2.6.4 ES-4G Quality Control QA

2.6.5 ES-4G Browse Product QA

2.7 ERBE-like Monthly Regional Averages (ES-9) Quality Flags (CER03)

The ES-9 stores data for each 2.5-degree region observed during a month. There are 10368 possible regions; a given region is viewed by the scanner several times as the spacecraft passes overhead. For each region, data is stored by the hour for each hour of each day in the month. Stored data includes the mean estimates of shortwave and longwave radiant flux at the TOA, the standard deviations of these estimates, the maximum and minimum estimate, and scene information or cloud condition. Similar parameters are determined for those scanner measurements that were identified as viewing clear-sky areas. Daily, monthly hourly, and monthly averages are also stored.

2.7.1 ES-9 Header Record / Metadata QA

2.7.2 ES-9 Record QA

2.7.3 ES-9 Parameter QA

The mechanism used to designate suspect data in this data product is to insert CERES fill values in the place of the parameter value when there is no data, when there is not enough data to make a calculation, or when the data calculated is out of range.

2.7.4 ES-9 Quality Control QA

2.7.5 ES-9 Browse Product QA

2.8 Single Satellite Footprint TOA and Surface Flux, Clouds (SSF) Quality Flags (CER11)

The Single Satellite CERES Footprint TOA and Surface Fluxes, Clouds (SSF) product is produced from the cloud identification, convolution, inversion, and surface processing for CERES. Each SSF covers footprints from a single hour and a single CERES scanner (3 channels) mounted on one satellite. The product has a product header and multiple records of 121 parameters or 282 elements for each footprint.

The major categories of data output on the SSF are:

1) CERES footprint geometry and CERES viewing angles
2) CERES footprint radiance and flux (TOA and Surface)
3) CERES footprint area statistics and imager viewing angles
4) CERES footprint clear area statistics
5) CERES footprint cloudy area statistics for two cloud height categories
6) CERES footprint cloud overlap conditions (4 conditions)
7) Footprint Imager Radiance Statistics (5 imager channels)

The SSF product will be produced daily starting with the TRMM launch. The SSF provides data needed to produce a production quality set of CERES Angular Distribution Models (CADM). At a later time, the archival SSF product will be reproduced using the production CADMs.

2.8.1 SSF Header Record / Metadata QA

Table 2-11. SSF Header Record Quality Indicators

Indicator Description	Data Type	Definition
Satellite name	64- bit ASCII	
CERES instrument name	32-bit ASCII	
Imager name	64- bit ASCII	
Number of imager channels used	16-bit Integer	1 to 20
Central wavelengths of imager channels (20)	32-bit Real	0.4 to 15
Generation date and time	152- bit ASCII	
Number of footprints	32-bit Integer	1 to 350000

2.8.2 SSF Footprint Record QA

N/A

2.8.3 SSF Parameter QA

SSF science parameters, for which the value is undetermined or determined to be incorrect, will contain CERES default values. The IES Footprint Quality Flags are copied unchanged on the SSF (See Table 2-2.) In addition, the following parameters provide general information, which may be of interest to scientists, about individual CERES footprints.

Table 2-12. SSF Parameter QA Indicators

Indicator Description	Data Type	Definition
Surface type index	16-bit Integer	1 to 20
Surface type percent coverage	16-bit Integer	0 to 100
CERES SW ADM type	16-bit Integer	TBD
CERES LW ADM type	16-bit Integer	TBD
CERES WN ADM type	16-bit Integer	TBD
Number of imager pixels in CERES FOV	16-bit Integer	0 to 9000
Imager percent coverage	16-bit Integer	0 to 100
Flag source of precipitable water	16-bit Integer	TBD
Shadowed pixels percent coverage	16-bit Integer	0 to 100
Notes on general procedure	16-bit Integer	TBD
Notes on cloud algorithms	16-bit Integer	TBD
Clear area percent coverage	16-bit Integer	0 to 100
Imager sunglint percent coverage	16-bit Integer	0 to 100
Snow/ice percent coverage	16-bit Integer	0 to 100
Fire percent coverage	16-bit Integer	0 to 100
Aerosol percent coverage	16-bit Integer	0 to 100
Flag type of aerosol	16-bit Integer	0 to 9999
Cloud layer area percent coverage (2)	16-bit Integer	0 to 100
Overlap condition weighted area percentage (4)	16-bit Integer	0 to 100

2.8.4 SSF Quality Control QA

2.8.5 SSF Browse Product QA

2.8.6 SSF Validation Product QA

2.9 Clear Reflectance History (CRH) Quality Flags (CER16)

The CRH product is a global averages product. The product contains values for several parameters the last time the region was viewed under clear-sky conditions. The data are stored on a 1/6 th-degree by 1/6 th-degree grid (2160x1080) for a total of 2,332,800 regions. The data coverage is

24 hour, and is updated every 10 days. The data product consists of a product header followed by fixed-length records organized according to the grid pattern. Each record has:

Visible albedo
Temperature
Viewing angles

The parameters are derived from cloud imager measurements by Subsystem 4. The CRH product is the same structure for both Moderate Resolution Imaging Spectrometer (MODIS) values and Visible Infrared Scanner (VIRS) values. There is a source indication on the header record.

2.9.1 CRH Header Record / Metadata QA

Table 2-13. CRH Header Record Quality Indicators

Indicator Description	Data Type	Definition
Imager source name	64-bit ASCII	

2.9.2 CRH Data Record QA

2.9.3 CRH Parameter QA

Default fill values for the parameters are used where there is no valid data. In addition, the following parameters are used to assess the quality of the CRH parameters.

Table 2-14. CRH Parameter Quality Indicators

Indicator Description	Data Type	Definition
Observation day	32-bit Real	Mission life
Observation time (fractional julian time)	32-bit Real	0 to 1
Narrowband ADM type	16-bit Integer	TBD

2.9.4 CRH Quality Control QA

2.10 Cloud Radiative Swath (CRS) Quality Flags (CER04)

The CRS contains longwave and shortwave radiative fluxes for the surface, internal atmosphere and TOA for each FOV. The CRS contains data for a 1-hour satellite swath (8-12 percent of the Earth) from one satellite.

For each CERES FOV, the CRS contain:

1) CERES FOV geometry, time, and scene data
2) CERES FOV satellite altitude radiance data
3) CERES FOV estimated TOA flux data
4) CERES FOV surface flux data
5) CERES FOV total-sky area data
6) CERES FOV clear-sky area data
7) Cloud category properties for two of four cloud height categories (low (L), lower middle (LM), upper middle (UM), and high (H)) over the CERES FOV
8) Overlap data for four of eleven cloud overlap conditions (clear, L, LM, UM, H, H/UM, H/LM, H/L, UM/LM, UM/L, LM/L) over the CERES FOV
9) CERES FOV surface radiative parameters
10) Atmospheric flux profiles for both clear-sky and total-sky at the surface, 500hPa, the tropopause, and the TOA over the CERES FOV
11) Flux adjustments (tuned-untuned) for clear-sky and total-sky at the surface and TOA over the CERES FOV
12) Adjustment parameters for clear-sky (note that these are calculated for both clear-sky and total-sky FOV)
13) Adjustment parameters for the two cloud categories over the CERES FOV
14) Auxiliary adjustment quality control flags

2.10.1 CRS Header Record / Metadata QA

2.10.2 CRS Footprint Record QA

2.10.3 CRS Parameter QA

In addition to the quality flags described below, the CRS contains the IES Footprint Quality Flag, defined in Table 2-2, and the SSF flags and parameters, defined in Tables 2-11 and 2-12.

Table 2-15. CRS Quality Flags (64 bits)

Flag Description	Number of Bits	Bit Definition
Constrainment status	32 bits	TBD
Sigma table configuration	32 bits	TBD

2.10.4 CRS Quality Control QA

2.11 Monthly Gridded Single Satellite Fluxes and Clouds (FSW) Quality Flags(CER05)

The Monthly Gridded Single Satellite Fluxes and Clouds (FSW) archival data product contains hourly single satellite flux and cloud parameters averaged over 1.0-degree regions. Each FSW covers a single month's swath from a single CERES instrument mounted on one satellite. The product has a product header and multiple records; each record contains spatially averaged data for an individual region.

The major categories of data output on the FSW are as follows:

1) Region data
2) Total-sky radiative fluxes at TOA, surface, and atmospheric levels
3) Clear-sky radiative fluxes at TOA, surface, and atmospheric levels
4) Cloud overlap conditions
5) Cloud category properties
6) Column-averaged cloud properties
7) Angular model scene classes
8) Surface-only data
9) Adjustment parameters

2.11.1 FSW Header Record / Metadata QA

2.11.2 FSW Record QA

2.11.3 FSW Parameter QA

The mechanism used to designate suspect data in this data product is to insert CERES fill values in the place of the parameter value when there is no data, when there is not enough data to make a calculation, or when the data calculated is out of range.

2.11.4 FSW Quality Control QA

2.12 Synoptic Radiative Fluxes and Clouds (SYN) Quality Flags (CER07)

The SYN contains regional longwave and shortwave radiative fluxes for the surface, internal atmosphere and TOA. The data are computed at 3-hour intervals on the CERES grid and are based on measurements from multiple EOS CERES instruments.

The SYN contains averaged:

1) Regional data
2) Clear-sky area scene data
3) Observed CERES TOA data
4) Cloud category properties for four (low, lower middle, upper middle and high) cloud height categories
5) Column averaged cloud properties for five (TOA SW, TOA LW, SFC LW, LWC and IWC) weighting schemes
6) Overlap data for eleven (clear, low (L), lower middle (LM), upper middle (UM), high (H), H/UM, H/LM, H/L, UM/LM, UM/L, LM/L) cloud overlap conditions
7) Angular model scene classes for the twelve ERBE scene types
8) Surface radiative parameters
9) Untuned radiative fluxes for both clear skies and total scene at the surface and the TOA
10) Tuned radiative fluxes for both clear skies and total scene at the surface, 500hPa, the tropopause and the TOA
11) Adjustment parameters for clear skies
12) Adjustment parameters for four (low, lower middle, upper middle and high) cloud height categories
13) Auxiliary adjustment quality control flags

2.12.1 SYN Header Record / Metadata QA

2.12.2 SYN Record QA

2.12.3 SYN Parameter QA

In addition to the quality flags described below, the SYN contains the CRS quality flags defined in Table 2-15.

Table 2-16. SYN Parameter Quality Indicators

Description	Data Type	Definition
Snow/ice percent coverage	32-bit Real	0 - 100
Smoke percent coverage	32-bit Real	0 - 100
Fire percent coverage	32-bit Real	0 - 100
Surface type percent coverage (20)	32-bit Real	0 - 100

2.12.4 SYN Quality Control QA

2.12.5 SYN Browse Product QA

2.13 Monthly Regional, Zonal, and Global Radiative Fluxes and Clouds (AVG/ ZAVG) Quality Flags (CER08/CER15)

AVG/ZAVG is an archival product produced for each spacecraft and for each combination of spacecraft. Initially at the TRMM launch, this product is produced in a validation mode every 3 months, or for 4 months a year. During these 18 months, the CERES Science Team will derive a production quality set of Angular Distribution Models, which are needed to produce the LW and SW instantaneous fluxes. Eighteen months after the TRMM launch, this product is archived and contains LW and SW fluxes at the tropopause and at 500 hPa pressure levels. Thirty-six months after the TRMM launch, this archived product contains LW and SW fluxes at 18 standard pressure levels. The pressure levels are in addition to fluxes at TOA and at the surface. In addition, the cloud and clear-sky properties are averaged between the 18 pressure levels, resulting in 17 vertical instances of the averaged cloud properties.

The AVG product contains a monthly and monthly hourly averages of the TOA and surface LW and SW radiative fluxes, together with LW and SW fluxes at standard pressure levels in between for each 1-degree equal angle region. The ZAVG product contains a monthly and monthly hourly averages of the same parameters for each zone and the globe. This final product also contains observed cloud and clear-sky properties at the standard 1-degree horizontal resolution.

AVG/ZAVG are composed of the following structures:

1) Regional (Zonal) data
2) Radiative fluxes for both clear-sky and total-sky at TOA

3) Cloud category properties for four (low, lower middle, upper middle and high) cloud layers
4) Adjustment parameters for four cloud layers
5) Column-averaged cloud properties for five (TOA SW, TOA LW, SFC LW, LWP, and IWP) weighting schemes
6) Adjustment parameters for five weighting schemes
7) Overlap data for eleven (clear, low (L), lower middle (LM), upper middle (UM), high (H), H/UM, H/LM, H/L, UM/LM, UM/L, LM/L) cloud conditions
8) Angular model scene classes
9) Atmospheric flux profile for clear-sky and total-sky
10) Flux adjustments for clear-sky and total-sky
11) Adjustment parameters for clear-skies
12) Surface data

2.13.1 AVG

2.13.1.1 AVG Header Record / Metadata QA

2.13.1.2 AVG Record QA

2.13.1.3 AVG Parameter QA

The mechanism used to designate suspect data in this data product is to insert CERES fill values in the place of the parameter value when there is no data, when there is not enough data to make a calculation, or when the data calculated is out of range.

2.13.1.4 AVG Quality Control QA

2.13.1.5 AVG Browse Product QA

2.13.2 ZAVG

2.13.2.1 ZAVG Header Record / Metadata QA

2.13.2.2 ZAVG Record QA

2.13.2.3 ZAVG Parameter QA

The mechanism used to designate suspect data in this data product is to insert CERES fill values in the place of the parameter value when there is no data, when there is not enough data to make a calculation, or when the data calculated is out of range.

2.13.2.4 ZAVG Quality Control QA

2.13.2.5 ZAVG Browse Product QA

2.14 Monthly Gridded Single Satellite TOA and Surface Fluxes/Clouds (SFC) Quality Flags (CER12)

The Monthly Gridded Single Satellite Fluxes and Clouds (SFC) archival data product contains hourly single satellite flux and cloud parameters averaged over 1.0 degree regions. Each SFC covers a single month swath from a single CERES instrument mounted on one satellite. The product has a product header and multiple records; each record contains spatially averaged data for an individual region.

The major categories of data output on the SFC are as follows:

1) Region data
2) Total-sky radiative fluxes at TOA and surface
3) Clear-sky radiative fluxes at TOA and surface
4) Column-averaged cloud properties
5) Angular model scene classes
6) Surface-only data

2.14.1 SFC Header Record / Metadata QA

2.14.2 SFC Record QA

2.14.3 SFC Parameter QA

The mechanism used to designate suspect data in this data product is to insert CERES fill values in the place of the parameter value when there is no data, when there is not enough data to make a calculation, or when the data calculated is out of range.

2.14.4 SFC Quality Control QA

2.15 Monthly TOA and SRB Averages (SRBAVG) Quality Flags (CER06)

SRBAVG is an archival product produced by Subsystem 10. There is one produced for each spacecraft and one for each combination. At the TRMM launch, this product will be produced in a validation mode for the first 18 months. During these 18 months, the CERES Science Team will derive a production quality set of Angular Distribution Models which are needed to produce the LW and SW instantaneous fluxes.

The SRBAVG product contains monthly and monthly hourly regional, zonal, and global averages of the TOA and surface LW and SW fluxes and the observed cloud conditions on a 1-degree equal-angle grid. The surface fluxes have been calculated from the TOA fluxes using parameterizations provided by the science team, instead of using the models provided by the SARB Subsystem. No flux fields are calculated at levels between TOA and the surface. The regional TOA fluxes are calculated using two methods, the ERBE-like interpolation method and the geostationary interpolation method.

SRBAVG is composed of the following structures:

On a Regional, Zonal, and Global Basis:

1) Regional parameters
2) Total sky radiative fluxes at TOA and surface
3) Clear sky radiative fluxes at TOA and surface
4) Angular model scene types
5) Column-averaged cloud properties for five weighting schemes: (TOA SW, TOA LW, SFC LW, LWP and IWP)
6) Surface data

2.15.1 SRBAVG Header Record / Metadata QA

2.15.2 SRBAVG Record QA

2.15.3 SRBAVG Parameter QA

The mechanism used to designate suspect data in this data product is to insert CERES fill values in the place of the parameter value when there is no data, when there is not enough data to make a calculation, or when the data calculated is out of range.

2.15.4 SRBAVG Quality Control QA

2.15.5 SRBAVG Browse Product QA

2.16 Gridded GEO Narrowband Radiances (GGEO) Quality Flags (CERX14)

The GGEO product is a single file containing a header record followed by multiple data records. The header record contains information to identify the product contents and version. These data are the CERES Data Product Code, the Data Starting and Ending Date, and the Product Creation Date and Time.

2.16.1 GGEO Header Record / Metadata QA

Table 2-17. GGEO Header Record Quality Indicators

Indicator Description	Data Type
CERES Data Product Code	32-bit ASCII
Data Starting Date	32-bit ASCII
Data Ending Date	32-bit ASCII
Product Creation Date	32-bit ASCII
Product Creation Time	32-bit ASCII

2.16.2 GGEO Record QA

Each data record, called an hourbox, contains data particular to a single grid region and hour. The number of hourboxes on the file is constant and is determined by the number of data hours per day, the maximum number of days per month, and the number of regions in the grid (8 hours per day x 31 days per month x 64800 regions on globe = 16,070,400 hourboxes). Hourboxes for which there are no ISCCP data are filled with default values.

2.16.3 GGEO Parameter QA

The data record (hourbox) contains three categories of data: Satellite and Hourbox ID information, Key Footprint Parameters, and Radiance Statistics.

- The **Satellite and Hourbox ID** information, as the name implies, identifies the hourbox as well as the satellite which collected the data within the hourbox. Although there are many grid regions on the Earth that are observed by more than one geostationary satellite, each hourbox contains only data from the closest observing satellite.

- The **Key Footprint Parameters** are data associated with the key footprint, the footprint which falls closest to the centroid of the region. These data are the time of the footprint and three angle measurements associated with the footprint: the cosine of the satellite zenith angle, the cosine of the solar zenith angle, and the relative azimuth angle.
- The primary data on the GGEO product are **Radiance Statistics**. These are visible and infrared radiance values averaged over a grid region every 3rd hour of each month. The statistics contain, in order, the calculated mean and variance, and the number of footprints used for the calculations.

2.16.4 GGEO Quality Control QA

2.17 Meteorological, Ozone, and Aerosols (MOA) Quality Flags (CERX06)

The MOA data product contains meteorological, ozone, and aerosol data for 1-hour, and is used by several of the CERES subsystems. The MOA data are horizontally regridded to conform with the horizontal resolution of the meteorological data. Profile data are interpolated vertically to conform with CERES requirements. All data are temporally interpolated to provide data to the CERES processing system on an hourly basis.

The MOA contains:

1) Surface pressure, geopotential height, skin temperature, and sea surface state
2) Vertical profiles of temperature and humidity for 58 atmospheric levels
3) Vertical profiles for 18 atmospheric levels below the tropopause of wind u-vector and v-vector data
4) Tropospheric height
5) Air mass index
6) Column precipitable water based on humidity profiles
7) Column precipitable water based on microwave measurements
8) Column averaged relative humidity
9) Vertical profile of ozone mixing ratios for 58 atmospheric levels
10) Column ozone
11) Aerosol optical depth

2.17.1 MOA Header Record / Metadata QA

2.17.2 MOA Grid Record QA

Table 2-18. MOA Regional Quality Flags (192 bits)

Flag Description	Number of Bits	Bit Definition
Source Surface Data	32 bits	0 = Unavailable >0 = Source, values TBD
Source Meteorological Profiles	32 bits	0 = Unavailable >0 = Source, values TBD
Source Microwave Precipitable Water	32 bit	0 = Unavailable >0 = Source, values TBD
Source Ozone Profile Data	32 bits	0 = Unavailable >0 = Source, values TBD
Source Column Ozone	32 bits	0 = Unavailable >0 = Source, values TBD
Source Aerosol Optical Depth	32 bits	0 = Unavailable >0 = Source, values TBD

2.17.3 MOA Parameter QA

2.17.4 MOA Quality Control QA

APPENDIX A

Abbreviations and Acronyms

Appendix A
Abbreviations and Acronyms

ADM	Angular Distribution Model
APD	Aerosol Profile Data
ASCII	American Standard Code for Information Interchange
AVG	Monthly Regional Radiative Fluxes and Clouds
AVHRR	Advanced Very High Resolution Radiometer
BDS	Bidirectional Scan
CADM	CERES Angular Distribution Model
CAL	Calibration
CERES	Clouds and the Earth's Radiant Energy System
CID	Cloud Imager Data
CRH	Clear Reflectance History
CRS	Clouds and Radiative Swath
DAAC	Distributed Active Archive Center
DMS	Data Management System
DMT	Data Management Team
EDDB	ERBE-Like Daily Database Product
EOS	Earth Observing System
EOS-AM	EOS Morning Crossing (Ascending) Mission
EOS-PM	EOS Afternoon Crossing (Descending) Mission
EOSDIS	Earth Observing System Data and Information System
ERBE	Earth Radiation Budget Experiment
ERBS	Earth Radiation Budget Satellite
FOV	Field-of-View
FSW	Monthly Single Satellite Fluxes and Clouds
GAP	Altitude, Temperature, Humidity
Gen	Generation
GEO	Geosynchronous Orbit
GGEO	Gridded GEO Narrowband Radiances
H	High
IES	Instrument Earth Scans
INSTR	Instrument
ISCCP	International Satellite Cloud Climatology Project
IWC	Ice Water Content
IWP	Ice Water Path
LaRC	Langley Research Center
L	Low
LM	Lower Middle
LW	Longwave
LWC	Liquid Water Content
LWP	Liquid Water Path
MAM	Mirror Antimotor Mosaic
MISR	Multiangle Imaging Spectral Radiometer
MOA	Meteorological, Ozone, and Aerosols

MODIS	Moderate Resolution Imaging Spectrometer
MWH	Microwave Humidity
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
OPD	Ozone Profile Data
PGE	Product Generation Executives
QA	Quality Assessment
QAE	Quality Assessment Executables
QC	Quality Control
Reg	Region
SARB	Surface and Atmospheric Radiation Budget
SBUV-2	Solar Backscatter Ultraviolet/Version 2
SCF	Science Computing Facility
SFC	Monthly Gridded Single Satellite TOA and Surface Fluxes and Clouds
SRB	Surface Radiation Budget
SRBAVG	Monthly averages for Top-of-Atmosphere and Surface Radiation Budget
SSF	Single Satellite CERES Footprint TOA and Surface Fluxes, Clouds
Std	Standard
SURFMAP	Surface Map
SW	Shortwave
SYN	Synoptic Radiative Fluxes and Clouds
TBD	To be determined
TOA	Top-of-the-Atmosphere
TRMM	Tropical Rainfall Measuring Mission
UM	Upper Middle
VIRS	Visible Infrared Scanner
WN	Window
ZAVG	Monthly Zonal and Global Radiative Fluxes and Clouds

APPENDIX B

References

Appendix B
References

1. CERES Date Products Catalog, Release 2, Version 1, November 1996

2 CERES Validation Plan, Release 2.1, October 1996
(http://asd-www.larc.nasa.gov/valid/valid.html)